

generally fogged that the density of a star of the nineteenth magnitude, or of even nebulosity of the same brightness, is not distinguishable. This glare, therefore, apparently places a limit on the photographic penetrative power of the instrument employed, and, as far as Dr. Roberts's conditions of observation are concerned, the limit for luminosity of the feebleness of about the eighteenth magnitude is reached. Perhaps for such a clear atmosphere as is experienced at Arequipa, in Peru, and like stations, and with instruments of larger aperture, even fainter stars might be reached. This is a subject, however, which requires considerable research before any very definite statement can be accurately made.

The next point dealt with is perhaps the most important of all. It is the general impression that if a photographic plate be exposed in a telescope for several hours, it will, on development, show more stellar images than if it had been exposed for one hour; indeed, the longer the exposure, the more detail will be impressed on the photographic plate, and one can quite imagine that if exposure were sufficiently long, the whole plate would be covered with images, indicating that we are practically surrounded by a wall of stars.

This, however, is not the case according to the investigations of Dr. Roberts, and he produces very strong evidence in his favour. If two exposures be made on one object, say, one lasting one and one-half hours, and another for twelve hours, and should the same amount of detail be depicted on each, the natural deduction would be that the longer exposure did not show any more detail than the shorter one, because there would be no more images to record. From a minute examination of photographs of the great nebula in Andromeda, in Orion, the group of the Pleiades, and the region of the Milky Way about Cygnus, Dr. Roberts finds that such is the case, and that lengthened exposure need not necessarily mean an increased number of stellar images. He is thus led to accept the fact as a demonstration "of the accuracy of the surmises of astronomers in the past, that the part of the starry universe visible from the earth is limited in extent, and that notwithstanding the enormous assistance afforded by the photographic method, we are again brought to a check because of the inadequacy of the powers we possess to enable us to peer beyond that part of space in the midst of which we are placed. . . ."

It would be interesting to inquire whether Dr. Roberts has examined other photographs of these regions taken by different observers who have also employed long exposures and other instruments, and, if so, whether his opinion as regards this point has been endorsed. Such an examination as here suggested might lend additional strength to the conclusion he has already drawn.

In directing attention to the evolution of stellar systems, the author places before his readers a series of beautiful illustrations of his plates showing rich fields of stars of various degrees of condensation; spiral nebulae varying as regards symmetry; circular, annular and irregular nebulae; and lastly, nebulae of a cloud-like nature, which cover enormous areas and are conspicuous by their great irregularity. The wonderful groupings into lines and curves of many of the stars in these

clusters and nebulae, and the forms of the nebulous matter, leave, as Dr. Roberts points out, no room for doubt that they are the effects of physical causes, and, on account of their persistency on the plates, are very improbably due to coincidence only. The author further differentiates between those stars which are actually involved in nebulae, and those which are situated simply in the line of sight, but do not conform with the trend of the spirals or with the curves of the nebulous stars involved in them.

Many other points of interest are referred to in these pages, among which we may mention the variability and motion of nebulae; these and others, however, we must leave to those of our readers who have the good fortune to examine the volume for themselves.

In the publication of this work, Dr. Roberts has not only nobly enriched astronomical science, but has raised a monument to himself which will last as long as astronomy has any interest for mankind. This handsome book, besides being a most valuable mine of information, serves not only as a demonstration of the success that has rewarded his efforts after an infinite amount of most skilful instrumental adjustment and working, but as an excellent example of the valuable work that can be accomplished single-handed when one is endowed with both the love for and the means of studying the oldest of the sciences.

WILLIAM J. S. LOCKYER.

TWO MONSTROUS REPTILES.

(1) *A Complete Mosasaur's Skeleton* and (2) *A Skeleton of Diplodocus*. Being Parts iv. and v. of vol. i. of "Memoirs" of the American Museum of Natural History. By H. F. Osborn. With 8 Plates and 28 Text Illustrations. (New York: The Knickerbocker Press, 1899.)

THE memoirs above-mentioned are the latest of a series which, though not yet in their second volume, have already taken their place in the foremost rank of zoological publications. For this praiseworthy result the world is largely indebted to the author of the present memoirs, through his great monograph on "The Extinct Rhinoceroses"—the third in order of succession to appear. That came to those cognisant of his rich resources and familiar with his former doings as the fulfilment of a desire, and in itself set a high standard of excellence. In the memoirs under review this has been fully maintained, both as regards text and illustrations, which are alike highly finished works of art, worthy a pupil of Huxley. The two sets of remains dealt with are equally remarkable—one for the fact that parts usually lost by decomposition after death are here preserved; the other as furnishing us, for the first time in an undisturbed state, with well-nigh half the axial skeleton of a colossus, whose backbone was hitherto known only by some few isolated vertebrae.

The specimen of the Mosasaur is from the famous Kansas Chalk, which vies only with that of Mesvin in yielding the remains of the later aquatic reptiles, as evidenced by the grand series preserved in the Brussels Museum. The specimen under consideration measures some thirty-feet in length, and is in detail noteworthy for the condition of its cervical vertebrae and limb skeleton, and

for the preservation of the cartilaginous sternum, sternal ribs, and coracoids, and laryngo-tracheal supports. Of the cervical vertebrae there were indubitably seven, and the lesser parts of these are so well preserved that the author is able to give a detailed account of the "atlas complex" and individual relationships of the "intercentra," admitting of comparison with the corresponding parts of recent reptiles. But one sacral vertebra is present, and of the twenty-two so-called "dorsals" ten are proved to have entered into the composition of the sternum. The limbs are of the usual Mosasaurian type, except for a broadening and shortening of the fifth metapodial in both fore and hind members; while the phalanges of the fourth and fifth digits of the manus are estimated as nine in number. The caudal vertebrae come in for consideration, and there is given a restoration of the entire skeleton in outline, and an accompanying attempt at that of the animal in the flesh. For this the author expresses his indebtedness to Mr. C. Knight, who, on the whole, does not seem to have been so successful as with some of his earlier efforts of the kind. The introduction of a "nuchal fringe" by analogy to *Platecarpus* is risky, and the contour of head and jaws grotesque, if not erroneous.

Concerning the affinities of the Mosasaurs, the author is unable to decide; for while showing them to be possessed of varanoid characters beyond those already recognised, he points to differences between the two groups, which he considers irreconcileable with the view that they sprang from a common stem. Here, however, he does not appear to have sufficiently considered the Dolichosaurian kinship, so strongly urged by Boulenger, supported by Dollo, and accepted by Smith Woodward; and his assertion that the presence of but seven cervical vertebrae is against this is unfortunate, since² there is reason to believe that in some members of that suborder the number was thus small. The great expansion and non-fenestration of the unossified portion of the coracoid is a feature in respect to which this *Tylosaurus* is on a closer structural equality with the Rhynchocephalia than with the higher Lacertilia; and if it be that the bone claimed by Baur as the quadrato-jugal in *Platecarpus* really represents that, in consideration of the condition and inter-relationships of the palatines, pterygoids, and vomers, so well known in certain Mosasaurs, there can be little doubt that these struck off from some reptilian type intermediate between the Rhynchocephalia and the higher Lacertilia as to-day represented, i.e. that they arose "at an early stage in the evolution of the Squamata, before the modern Lacertilia and Ophidia had become differentiated," as Smith Woodward has so aptly remarked. Our greatest desideratum in the osteology of these creatures is a fuller knowledge of the posterior portion of their maxillo-jugal arcade, and it is unfortunate that with the present specimen, in which the conditions for preservation have been so favourable, that has been crushed.

Diplodocus is a notorious member of the Jurassic quadrupedal Dinosaurs, believed to have been an aquatic vegetable feeder; and, as already remarked, a full acquaintance with its axial skeleton has been a desideratum. The present specimen was obtained from the Como Bluffs

of Wyoming, by a prospecting party led by the author in 1897. Hopes of the recovery of the entire skeleton proved false, but there were obtained a complete set of caudal vertebrae, together with the greater portion of the sacrum, hip-girdle and femur, all in an undisturbed state, and also fragments of the rest of the vertebral column and the ribs. Passing over important details concerning the cervical and so-called "dorsal" and pre-sacral vertebrae, with which the memoir deals in detail, it is as concerning the posterior of the latter, together with the sacral and caudal, and the ilium, that interest is greatest. The overlapping, by forward extension of the ilium, of certain free lumbar ribs with accompanying co-ossification of parts furnishes an interesting feature of convergence towards the Ratite bird type. Passing on, the author remarks that *Diplodocus* "gives us a new . . . conception of the Cetiosaur," as involving the following interesting facts. He points out that the tail—some thirty feet in length—constitutes one-half of that of the whole animal, that the sacral spines mark the highest point in the backbone, and that the sacrum and ilium "come as a centre of power and motion"—the whole set of parts being so disposed as to lead us to regard the tail (which undoubtedly served as a propeller) as a "lever to balance the weight of the dorsal vertebrae" and the anterior portion of the body. He further points to a "balance between the opisthocœlous pre-sacrals and the procœlous post-sacrals," and draws the conclusion that the dominating principle of this great backbone is "maximum strength with minimum weight," while (to him) the whole is a mechanical triumph of great size, lightness and strength, which "baffles the Lamarckian as well as the Darwinian."

Beyond the more salient features above recapitulated, these memoirs are a storehouse of carefully recorded detail, of immense service for reference. Of the illustrations, no praise can be too high. There are eight plates, of which three are devoted to the Mosasaur, five to the Dinosaur; and all, with the exception of the third, which is an enlarged copy of a restoration of the skeleton incorporated in the text, are photographs of great merit. In addition, there are twenty-eight text illustrations, which, so far as they delineate parts of the actual remains, are ideal.

In conclusion, a word or two as to terminology and a looseness of expression, which we regret. In describing the unossified remnant of the coracoid as an "epicoracoid cartilage," and (using the term in its noun form) as an "epicoracoid" on one and the same page, the author is perpetuating a prevailing error against which we have more than once protested. The term "epicoracoid" is only applicable when a distinctly segmented element is present. Unfortunate, again, is the use of the term (p. 181) "sterno-coracoid plate." The sternum, which is apparently meant, is compared with that of certain living lizards; but when of these it is found that while at most three pairs of ribs contribute to its formation, in two of the species a second sternal cartilage is present, the comparison of *Tylosaurus*, with its ten pairs of costal ribs, is at least strained. Indeed, in its elongation and apparent longitudinal cleavage—its two most distinctive characters—the sternum of this aquatic reptile

anticipates conditions independently realised later in time by that of certain Cetacea. Equally regrettable is the application of the term "dorsal" to those vertebræ possessed of free ribs. This term is one of orientation, and "thoracic" would have been preferable, except that in *Diplodocus* all the vertebræ between the third or fourth cervical and sacrum are rib-bearing. The old terms "thoracic" and "lumbar" have ceased to be tolerable in their original sense; and in view of the general presence of lumbar ribs among the terrestrial vertebrata and of the importance, both morphologically and physiologically, of the costal sternum, the suggestion that in the future we must enumerate the parts of the pre-sacral vertebral column of the Amniota in relation to the sternum may be revolutionary, but it will assuredly have to be adopted.

Zoology is pre-eminently that branch of pure science cultivated in the States, and our American *confrères* have a partiality for "big" game. It is pertinent to the present occasion, with its allusions to the Cetacea, to remark that rumour reaches us that they have lately come into possession of a complete *Zeuglodon* skeleton. If so, we can desire nothing better than that it may be monographed either in or on the lines of the memoirs under review; and we sincerely hope that the treasure in store will prove a more genuine concern than that of the famous giant Cetacean now preserved in the Palaeontological Division of the Berlin Museum, which, having been publicly exhibited in that city as a mysterious creature of some 114 feet in length, was proved by Johannes Müller to embody the remains of individuals of two distinct species, and by him reduced to the less pretentious proportions of but some sixty to seventy feet.

We note that in the description of the *Tylosaurus* limb (Fig. 9) the word "left" should read "right"; and that in the table on p. 212, the reputed length of *Diplodocus* in metres is misleading, by omission of that of the caudal vertebræ, which, if added, would more than double the record given.

G. B. H.

A NATURALIST IN CHILE.

Temperate Chile. A Progressive Spain. By W. Anderson Smith. Pp. x + 400. (London: Adam and Charles Black, 1899.)

M R. ANDERSON SMITH, formerly a member of the Scottish Fishery Board, is well known for his sympathetic descriptions of the wild life of the western highlands of Scotland. In the course of a visit to southern Chile a few years ago, the object of which is not clearly stated, but appears to have been some study of natural conditions, possibly on behalf of the Chilean government, he made notes on the country from many points of view, which are published in the volume before us.

The author's style is original, and indeed a little difficult on account of the wealth of simile and half-concealed allusion which it displays, so that the reader's mind is every now and then drawn from the matter in hand to think who "Thomas, not the rhymier, but the prosler" may be, to marvel why Chile should be termed a "toy republic," to recollect where the "comforts of the Salt-market" originated, or even to wonder if "Fresh fields

and pastures new"—applied to a forest country too—may after all be the correct quotation. The arrangement of the matter in the descriptive parts is not systematic, and one can only gather the dates of the visits to various settlements with difficulty and without precision, which in a description of a progressive country is a real drawback. The map of Chile supplied, although clear and full for its scale, ought to have been supplemented by a cutting from the Admiralty chart of the neighbourhood of Chiloe, the topography of which cannot be found in any English atlas; without a detailed map the description of the various short journeys is not easy to follow.

Apart from these details of literary form and illustration, the book is both charming and valuable. It deals with a region of which little or nothing has been written in English by any naturalist since Darwin's "Voyage"; and it appears at a convenient time, for the Chilean government is again exerting itself to induce emigrants from northern Europe to make their home in the new lands of the far south.

The descriptions given of the civilisation, social life, and political systems of the Chileans are not attractive. How far they are just we cannot say; but it would perhaps be fairer to judge the people and methods of any republic in Latin America by comparison with those of the other republics than by any absolute standard or even by the criteria of Europe. Still, for any one who contemplates residence in Chile, the opinion of an observer so competent and impartial as Mr. Anderson Smith is of very great value, and should be carefully considered.

The struggle of high culture with barbarism in southern Chili is almost pathetic. Luxurious Pullman cars land the passenger in the midst of literally pathless forests, through which a track must be cut before a horse can pass. Yet wires fixed to the trees allow of telegraphic and telephonic communication with hamlets which lie weeks apart for the traveller. One reads with envy of a postal system so generous that newspapers are carried free in the mails, and with disgust of post-office administration so hopeless that letters lying in the head-office at Valparaiso are refused to the addressee on application, in order to save the trouble of looking for them, and afterwards returned to Europe.

The thriftlessness of the lower classes, half or wholly Araucanian, is horrifying even to one accustomed to the not too enterprising crofters of the West Highlands. They live contentedly in houses or huts without furniture, and in matters of food take little thought for the morrow or even for the day. Mr. Smith found a number of well-housed Indians with boats and fishing tackle at a station in Chiloe quite without food, and with the utmost difficulty induced them to take out a net. The result was good—"A second draw produced a fair supplement, but was purposely taken by the lazy rascals where the chance was less. A further draw we could not persuade them to try. Why? Because they would have required to carry the fish to the house, a hundred yards or so from the river, for there were at least three hundredweight of beautiful robalo some 6 to 8 pounds weight each. And yet these people were starving!"

The heavy rainfall and mild climate of the south of Chile produces a forest growth of a luxuriance and variety more to be expected in the torrid than in the temperate